NetZero Plus (NZ+)
Joint Capability Technology Demonstration

5 March 2009

Report Documentation Page

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14. ABSTRACT

15. SUBJECT TERMS

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unclassified	**unclassified**	**unclassified**	**Same as Report (SAR)**	**25**	

NetZero Plus JCTD


Foamed Tent


LED Lighting


DREAM (3kW)


Electro-Luminescence


Dome w/ Alt Energy


EPCC


PowerShade (1 – 3kW)

JCTD BUDGET

	FY08	FY09	FY10
AS&C (Cash)	$2.0M	$2.0M	$2.0M
Army REF / Energy Security TF (Cash)	$0.75M	$0.75M	$0.75M
TOTAL CASH	$2.75M	$2.75M	$2.75M
Service In-Kind Contributions	$12.33M	$11M	$6M
Total	$15.05M	$13.75M	$8.75M

Total Program Cost: $37.55M

Warfighter Problem / Solution

- **Problem:** Vulnerable lines of communication are subject to attack. Logistics convoys carry all classes of supplies to include fuel for power generation at Forward Operating Bases

- **Solution:** Leverage GOTS and COTS technologies to reduce fuel requirements at forward operating bases through reduced energy demand, efficient power distribution and increased alternative supply.

MANAGEMENT TEAM

- **Lead Service:** Army
- **COCOM Sponsor:** USCENTCOM
- **Technical Manager:** Power Surety TF
- **Operational Manger:** USCENTCOM J8
- **Transition Manager:** PM-MEP
- **Supporting CoComs:** USSOUTHCOM
- **Supporting Services/Agencies:** DLA, USMC

The Problem

The Need… Recommended a JCTD

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JOINT STAFF RAPID VALIDATION AND RESOURCING REQUEST

(U) Title: Renewable Energy System

(U) Submitted by: Commanding General, Multi-National Force-West (MNF-W)

(U) Date Certified/Prioritized by Combatant Commander: July 25, 2006

(U) Relative Priority: Priority 1

(U) General Description:

(U//FOUO) Electrical power is a I MEF (Fwd) mission-critical requirement, without which operations in Multi-National Force West (MNF-W) will be severally degraded. More than ever our operating forces rely on the use electrical power to support critical command and control (C2) functions; intelligence, surveillance, and reconnaissance (ISR) assets; and life support services. To improve the security posture of the Al-Anbar Province of Iraq, MNF-W requires a renewable and self-sustainable energy solution to support forward operating bases (FOBs), combat outposts (COPs), and observation posts (OPs) throughout MNF-W's battlespace.

(U//FOUO) Current means of supporting MNF-W's outlying bases consist of frequent logistic resupply convoys of Class I (subsistence), Class III (petroleum, oil, and lubricants), and Class V (ammunition), with a preponderance of Class III (petroleum). The constant threat of improvised explosive devices (IEDs), rocket propelled grenades (RPGs), and small arms fire (SAF) attacks along known ground lines of communications (GLOCs), and the necessity to traverse them to reach our outlying bases, places our Marines, soldiers, and sailors in harm's way each time we send out a convoy.

(U//FOUO) Current solutions-such as providing additional security to our logistics convoys and conducting convoy operations during the hours of darkness-are inadequate, as they do not reduce the number of convoys on the road. Additionally, these current solutions divert our focus of effort from developing the Iraqi Security Force (ISF) to providing convoy security for our own logistics support. A proposed alternate solution-one that reduces the number of convoys while providing an additional capability to outlying bases-is to augment our use of fossil fuels with renewable energy, such as photovoltaic solar panels and wind turbines, at our outlying bases. By reducing the need for Class III (petroleum) at our outlying bases, we can decrease the frequency of logistics convoys on the road, thereby reducing the danger to our Marines, soldiers, and sailors.

(U//FOUO) Additionally, as we transfer control to the Iraqis, the addition of renewable and self-sustainable energy at the outlying bases will enable the Iraqis to operate independently, lessening the need for Coalition Forces to provide future logistics support.

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- 1 -

By reducing the need for Class III (petroleum)…we can decrease the frequency of logistics, convoys on the road, thereby reducing the danger to our Marines, Soldiers and Sailors.

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HEADQUARTERS
MULTI-NATIONAL CORPS - IRAQ
BAGHDAD, IRAQ
APO AE 09342

REPLY TO ATTENTION OF:
FICI-GT-FMD

17 FEB 07

MEMORANDUM THRU Commander, Multi-National Force-Iraq, APO AE 09342-2001

FOR Commander, United States Central Command, CCJ8, 7115 South Boundary Blvd, MacDill AFB, Florida 33621-5101

SUBJECT: Candidate Joint Urgent Operational Need (JUON) Statement for Renewable Energy System (U)

1. (U) Reference: Joint Staff Rapid Validation and Resourcing Request, Title: Renewable Energy Source, 25 Jul 06.

2. (U/FOUO) Request CENTCOM review the concept, capabilities, and requirements of the Renewable Energy System candidate JUON towards feasibility and applicability in supporting military operations in Multi-National Force-West (MNF-W) battlespace. To improve the security posture of the Al-Anbar Province in Iraq, MNF-W is requesting a renewable and self-sustainable energy solution to support their forward operating bases (FOBs), combat outposts (COPs), and observation posts (Ops).

3. (U/FOUO) A review by the MNC-I staff of this candidate JUON validates the requirement; however, there are concerns regarding the maturity of the technology and whether the benefits are such that they warrant implementation at this time. Request CENTCOM conduct a scientific and technological review of this JUON candidate and provide a developmental way ahead. And if this technology is not mature enough to develop an operational test system by Jan 08, then request this technology be pursued via other DoD avenues, such as an Advanced Concept Technology Demonstration (ACTD) or Joint Concept Technology Demonstration (JCTD).

4. (U) Point of contact is LTC Donald Koehler, Chief, C-3 FMD, DSN: 318-822-4013, email: donald.koehler@s-iraq.centcom.smil.mil

RAYMOND T. ODIERNO
Lieutenant General, USA
Commanding

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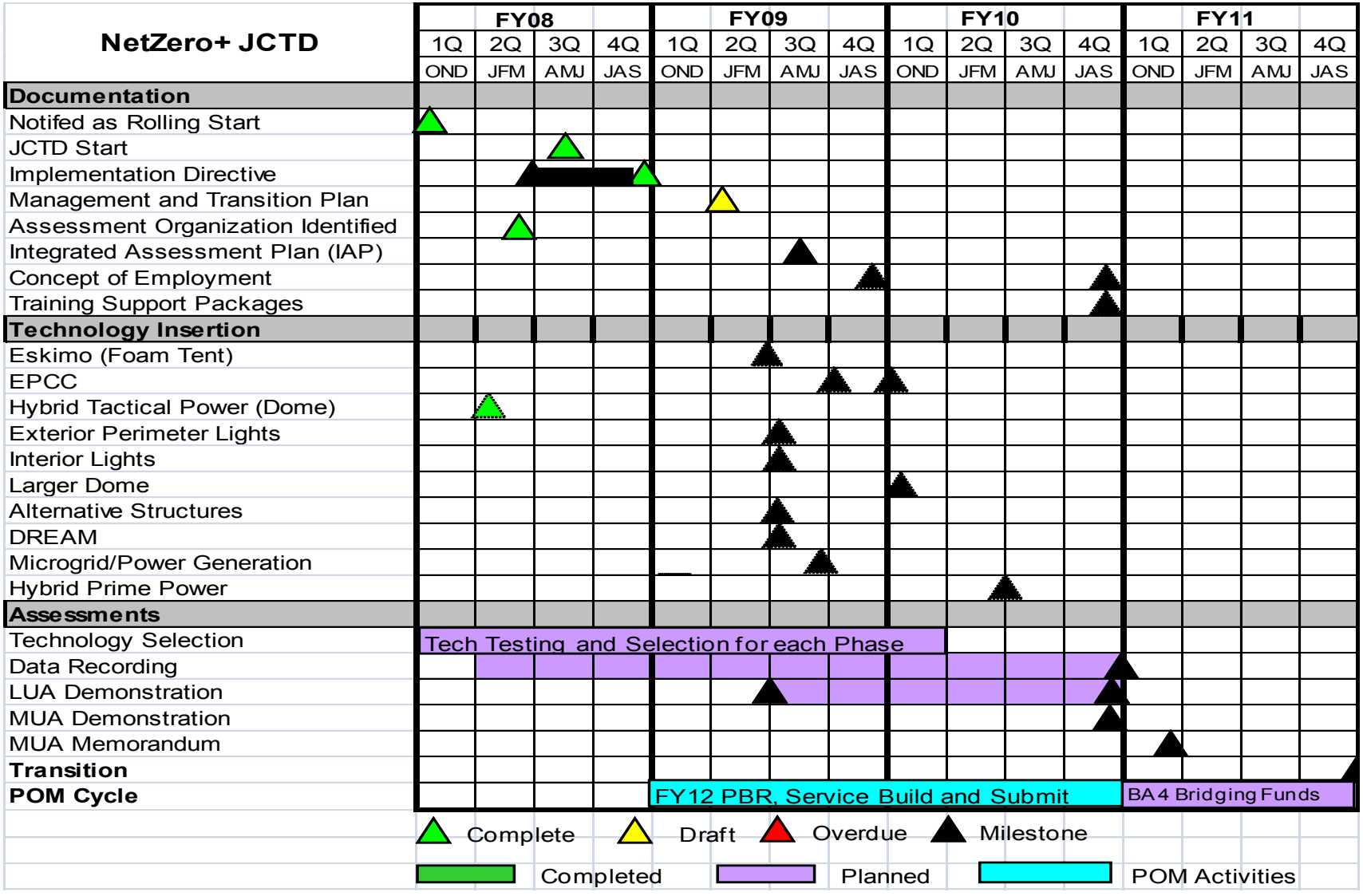
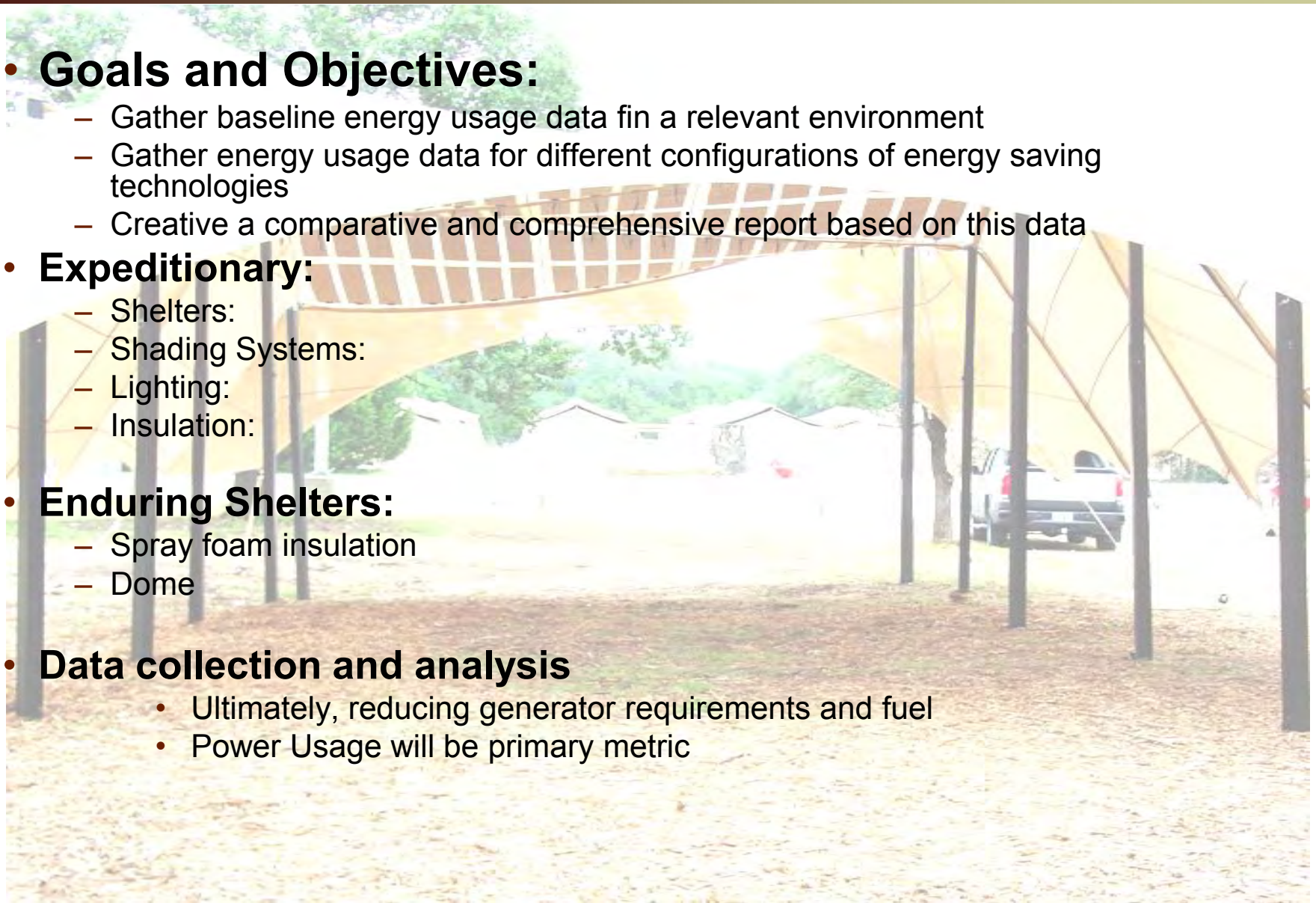
Request this technology be pursued via other DoD avenues, such as…Joint Concept Technology Demonstration (JCTD).

NetZero Plus JCTD Program Schedule



Energy Efficient Shelter Evaluation Overview



- **Goals and Objectives:**
  - Gather baseline energy usage data fin a relevant environment
  - Gather energy usage data for different configurations of energy saving technologies
  - Creative a comparative and comprehensive report based on this data
- **Expeditionary:**
  - Shelters:
  - Shading Systems:
  - Lighting:
  - Insulation:
- **Enduring Shelters:**
  - Spray foam insulation
  - Dome
- **Data collection and analysis**
  - Ultimately, reducing generator requirements and fuel
  - Power Usage will be primary metric

Energy Efficient Structures-Expeditionary

Technologies being brought to the table

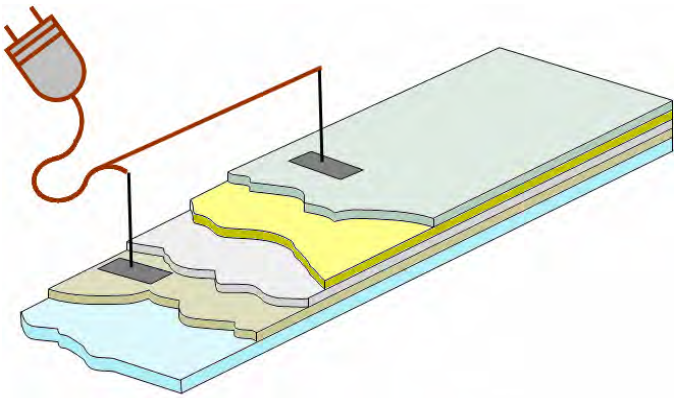
- New airbeam energy efficient tents
- Power Shades

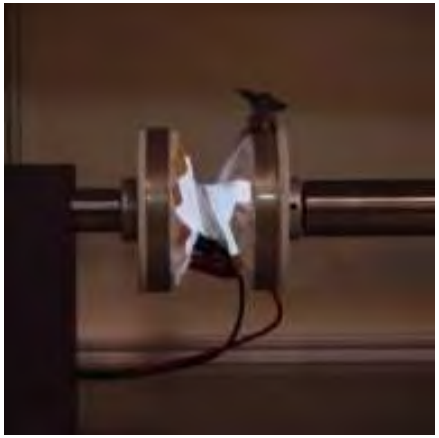
- Solar Shades
- Honeycomb insulation liner (temper tent)
- Air gel insulation liner (temper tent)

Energy Efficient Structures-Expeditionary

Flexible, Electroluminescent (EL) Lighting Surfaces:

- Provide general illumination for shelters
- Decreases deployment time, weight, and cube
- Polymer-based lighting surfaces are flexible, durable and safe
- Can be printed on multiple substrates (including fabric)
- Puncture of EL lamp does not cause failure





Energy Efficient Structures - Enduring

Dome Structure

- 2 Story Dome
- Size - 72’ x 27’
- Energy efficient HVAC units
- Earth Return Ventilation (ERV)
- Energy efficient lighting
- Brigade TOC (footprint)

Energy Efficient Structures - Enduring

Exterior Spray Foam

- Foam insulate temporary tents, containerized living units, office spaces and freezer units to decrease air and dust infiltration.

- Foam is deployed using self-contained, self-powered, Conex-transported spray kits.

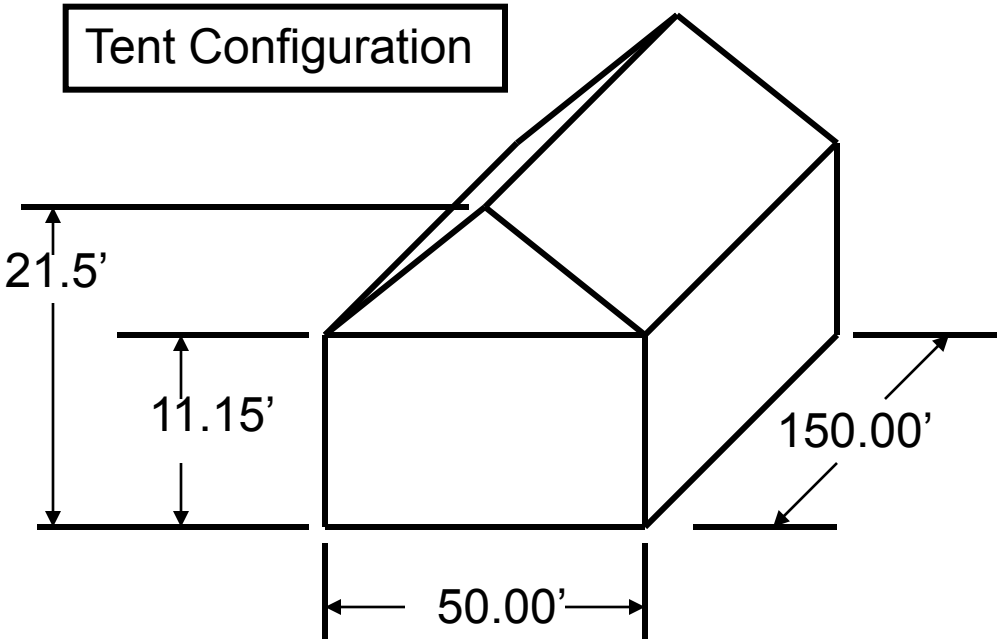
- Foam is applied by experts who prepare the structure, apply foam, apply protective coating, and monitor air exchange.

Before

After

Power and Environmental Analysis - Preliminary

Tent Configuration



R-Value: A measure of the ability to retard heat flow rather than transmit heat

k-factor: Thermal Conductivity is the measure of a material’s ability to transfer heat.

$$R = \frac{\text{Thickness of material (in)}}{\text{k-factor (BTU-in/hr-Sqft- F)}}$$

$$q = k.A \frac{Tow - Tiw}{L}$$

q – Heat Transfer rate
k – Thermal conductivity
A – Material Total Area
Tow – Wall outside temp
Tiw – Wall inside temp
L – Wall Material Thickness

Tent Parameters	Un-foamed Tent	Foamed Tent	Comments
Tent Surface Area (Roof and Walls)	**13,093 Sq Ft**	**13,093 Sq Ft**	**Calculated**
Tent Air Volume	**122,437.5 Cu ft**	**122,437.5 Cu Ft**	**Calculated**
Tent Wall and Roof Thickness	**.018 Inches**	**3.00 Inches**	**Unfoamed tent – Measured; Foamed tent – avg. thickness**
Tent Material R Value	**R1**	**R5.6 – R8 per inch; Avg: R5.6 /in = R16.8; R6.8/in =R20.4**	**Base on Contractor = R13 Base on DOE Data = R16.8**
Tent Material	**PVC - Fabric**	**Polyisocyanurate (Sprayed Foamed)**	**Manufacturer: Losberger Intertent GmbH**
Estimated Electrical Loads	**2.5 kW (1.0 – 1.2, lights; 1.3, mission)**	**TBD**	**Tent measured elec. load**
Tent personnel Capacity	**150**	**150**	**Avg occupancy per rotation is approx. 100 people**

Data Summary Sheet
Preliminary

Description	Set Parameters	Un-foamed Tent (LSA) Measured Data (Winter)	Un-foamed Tent (LSA) Actual Measured Data (Summer; Jul - XXXX)	Foamed Tent Measured Data (Winter)	Foamed Tent Measured Data (Summer)
No. Person	150	Approx. 100 people			
Environmental : (°F) Tent Inside	75 - 85	Day – 72.1 Night – 60.5			
Environmental : (°F) Tent Outside	AR 70 – 38 -25°F to 125°F	Day – 56.6 Night – 45.1			
Environmental : (°F) Inside Wall	TBD	Day – 62.2 Night – 43.4			
Environmental : (°F) Outside Wall	TBD	Day – 63.6 Night - 41.9			
Lights Electrical Loads	TBD	1.0 – 1.2 kW			
Mission Electrical Loads	TBD	1.3 kW			
Tent Material		PVC Fabric			
Tent R Value	TBD	.018 inch thk (single Layer, no insulation) = R1	.018 inch thk (single Layer, no insulation) = R1	3.00 in thk = R13 – 16 per Contractor; R20.4 per DOE Data Sheet	3.00 in thk = R13 – 16 per Contractor; R20.4 per DOE Data Sheet
ECU kW (Max)	TBD	106. 614 kW (Heat)			
Total kW Load	XXXX.XX kW	108.799 kW (Heat + Tent Electrical Load)			
Total Cooling/Heating Load (incl solar)	Based on computer Simulation	Based on computer Simulation			

Data Questionare - Preliminary

Using the following scales, please rate your experience with foamed tents by circling the appropriate number for each item.

[Effectiveness item #1]

1. How effective did you find the foaming of the tent to be?

1	2	3	4	5	6	7
Not at all effective						Very effective

[Effectiveness item #2]

2. On average, how comfortable was the temperature inside the foamed tent?

1	2	3	4	5	6	7
Not at all comfortable						Very comfortable

[Sustainability item #1]

3. Please rate the availability of materials for repairing the foamed tent:

1	2	3	4	5	6	7
Not at all available						Very available

[Sustainability item #2]

4. Please rate the availability of personnel for maintenance of the foamed tent:

1	2	3	4	5	6	7
Not at all available						Very available

[Compatibility/Interoperability item]

5. Please rate the compatibility of the foam with other components of the tent structure:

1	2	3	4	5	6	7
Not at all compatible						Very compatible

[Impact on operations item]

6. Please rate the impact of the foamed tent on day-to-day operations and mission requirements:

1	2	3	4	5	6	7
Very ***negative*** impact			***Neutral*** impact			Very ***positive*** impact

[Effectiveness item #3]

7. Overall, how satisfied were you with the foaming of the tent?

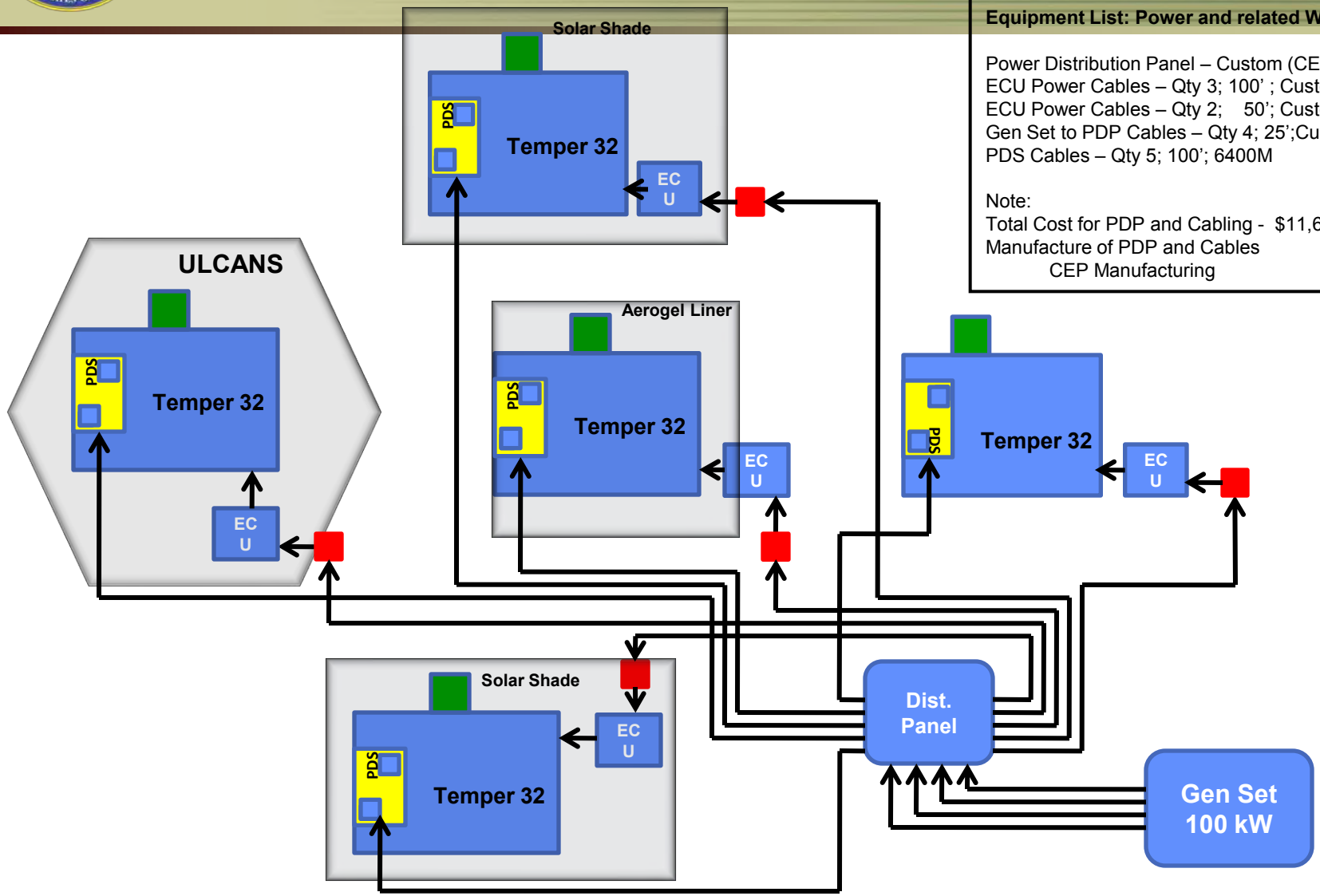
1	2	3	4	5	6	7
Not at all satisfied						Very satisfied

Expeditionary Power Assessment
ECU and Mission Load

Equipment List: Power and related Wiring

Power Distribution Panel – Custom (CEP)
ECU Power Cables – Qty 3; 100' ; Custom; P/S - CLF
ECU Power Cables – Qty 2; 50'; Custom; P/S – CLF
Gen Set to PDP Cables – Qty 4; 25';Custom; CL
PDS Cables – Qty 5; 100'; 6400M

Note:
Total Cost for PDP and Cabling - $11,626.25
Manufacture of PDP and Cables
CEP Manufacturing



Temp Data Logger – Monitor Int. & Ext. Tent Wall Temperatures - 2 places

AC Data Logger – Monitor ECU Load (1 - Data Logger)

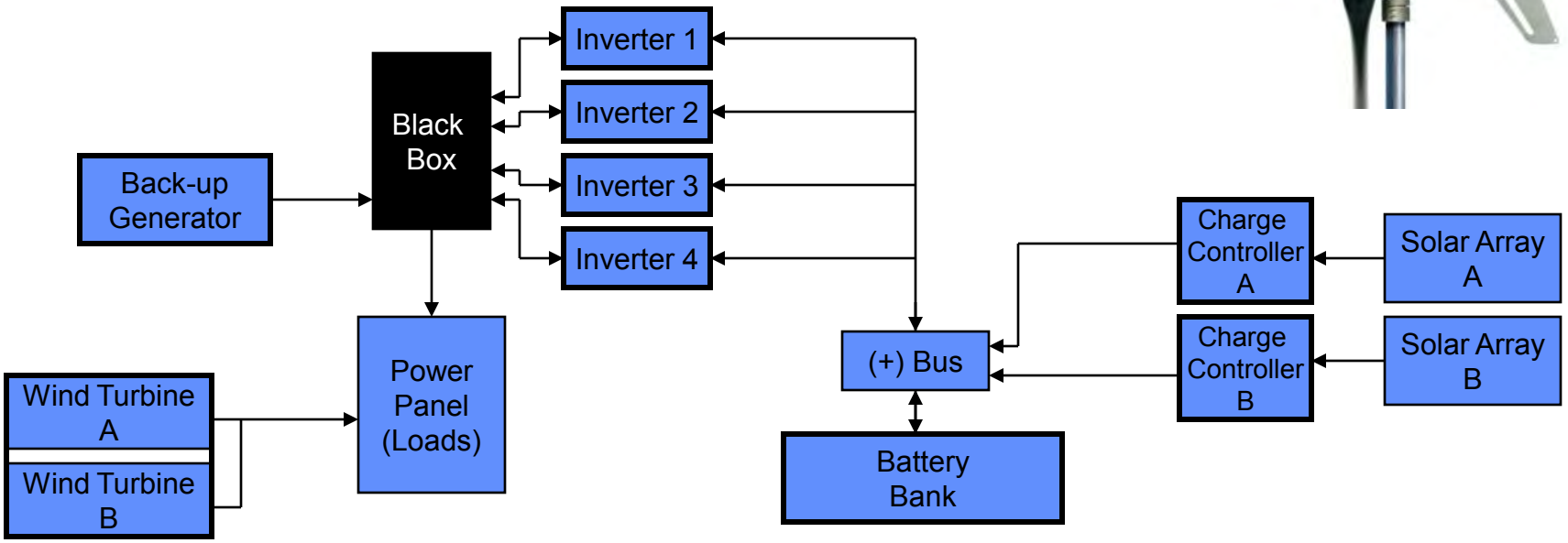
PDS

AC Data Logger – Monitor Mission Loads and Lightings (2 – Data Loggers)

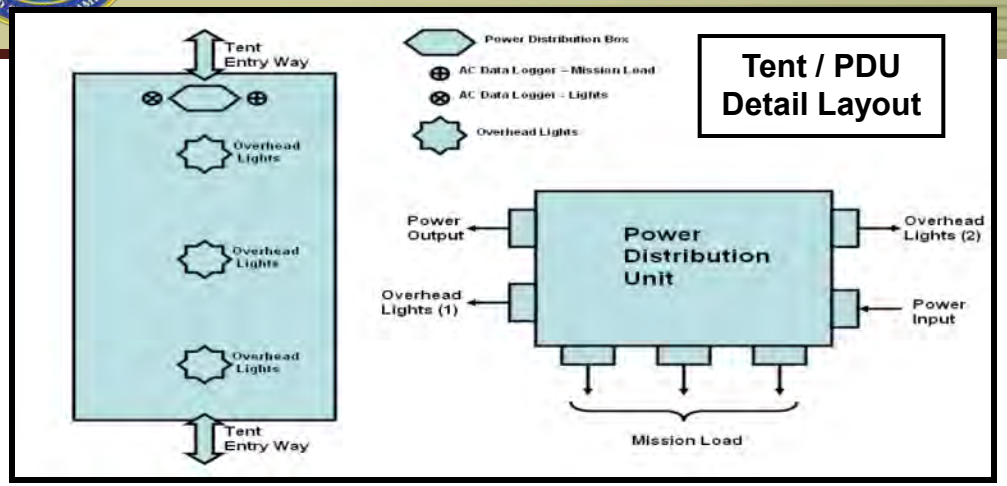
Enduring Power Assessment - Dome Solar and Wind Data

- **Dome Renewable power system equipment we are monitoring:**

- **Renewable Sources at COB King**
  - 2 solar charge modules
  - 2 wind turbines
  - 1 generator
  - 4 inverters
  - 1 battery bank



Enduring Power Assessment - Foam ECU and Mission Load



70 kW Gen Set

X-Former Unit 120/208 Vac, 3Ø

TENT 5 | TENT 4 | TENT 3 | TENT 2 | TENT 1

ECU 60T | ECU 60T | ECU 60T | ECU 60T | 30T | 30T

MAIN TENTS

800 kW Gen Set

70 kW Gen Set

400 kW Gen Set

70 kW Gen Set

MESS HALL

TENT 11

ECU 60T

400 kW Gen Set

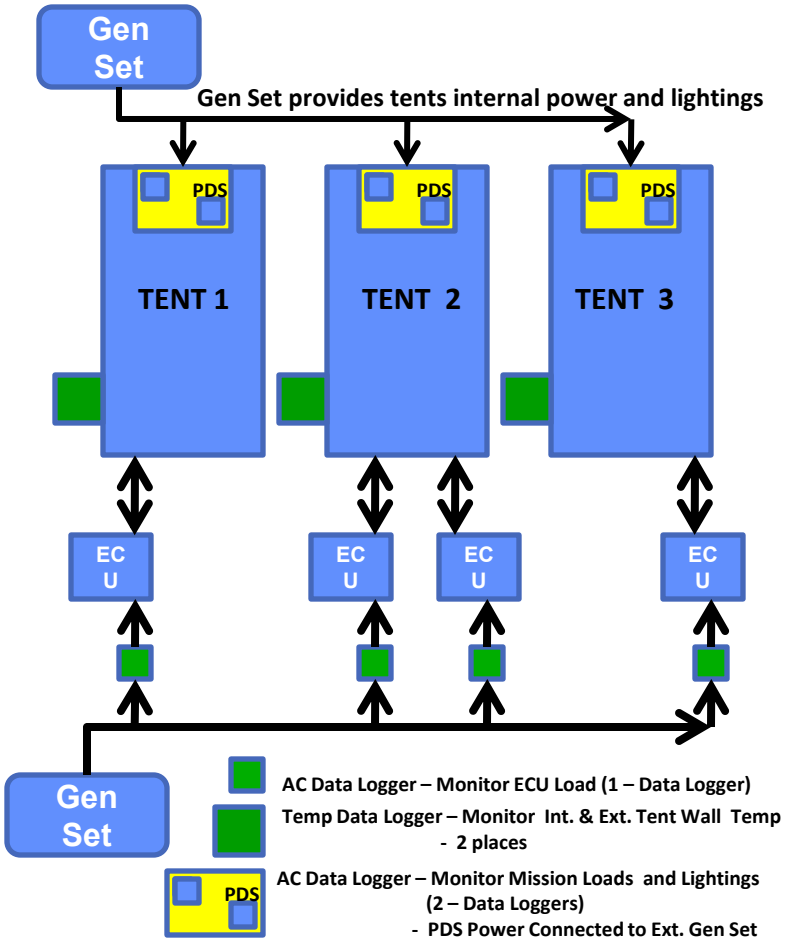
FOAM TENT

ECU 60T

70 kW Gen Set

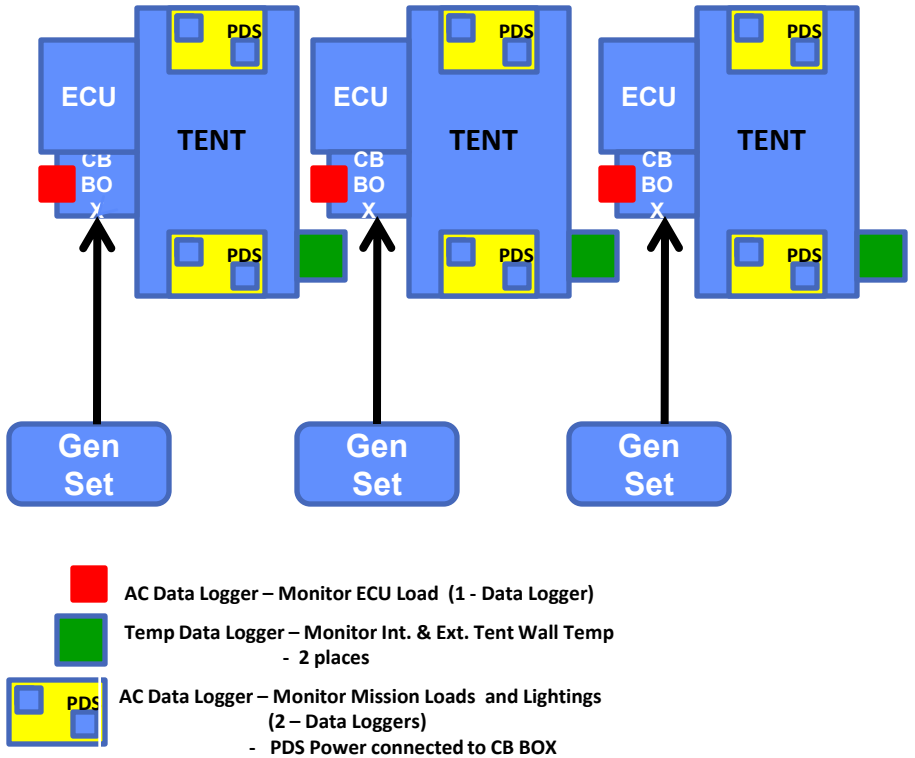
MAIN Tents:	Data Logger Qty
• Lights:	5
• Mission Load	5
• ECU 60T	4
• ECU 30T	2
• Gen Set 800 kW	1
• Gen Set 400 kW	1
• Gen Set 70 kW	2
MESS HALL Tent:	
• Lights	1
• Mission Load	1
• Gen Set 400 kW	1
• Gen Set 70 kW	1
FOAM Tents:	
• Lights	1
• Mission Load	1
• Gen Set 70 kW	1
• Gen Set/ECU 30T	1
TOTAL	**28+2 Spare = 30**

Enduring Power Assessment - Foam vs Unfoamed ECU and Mission Load



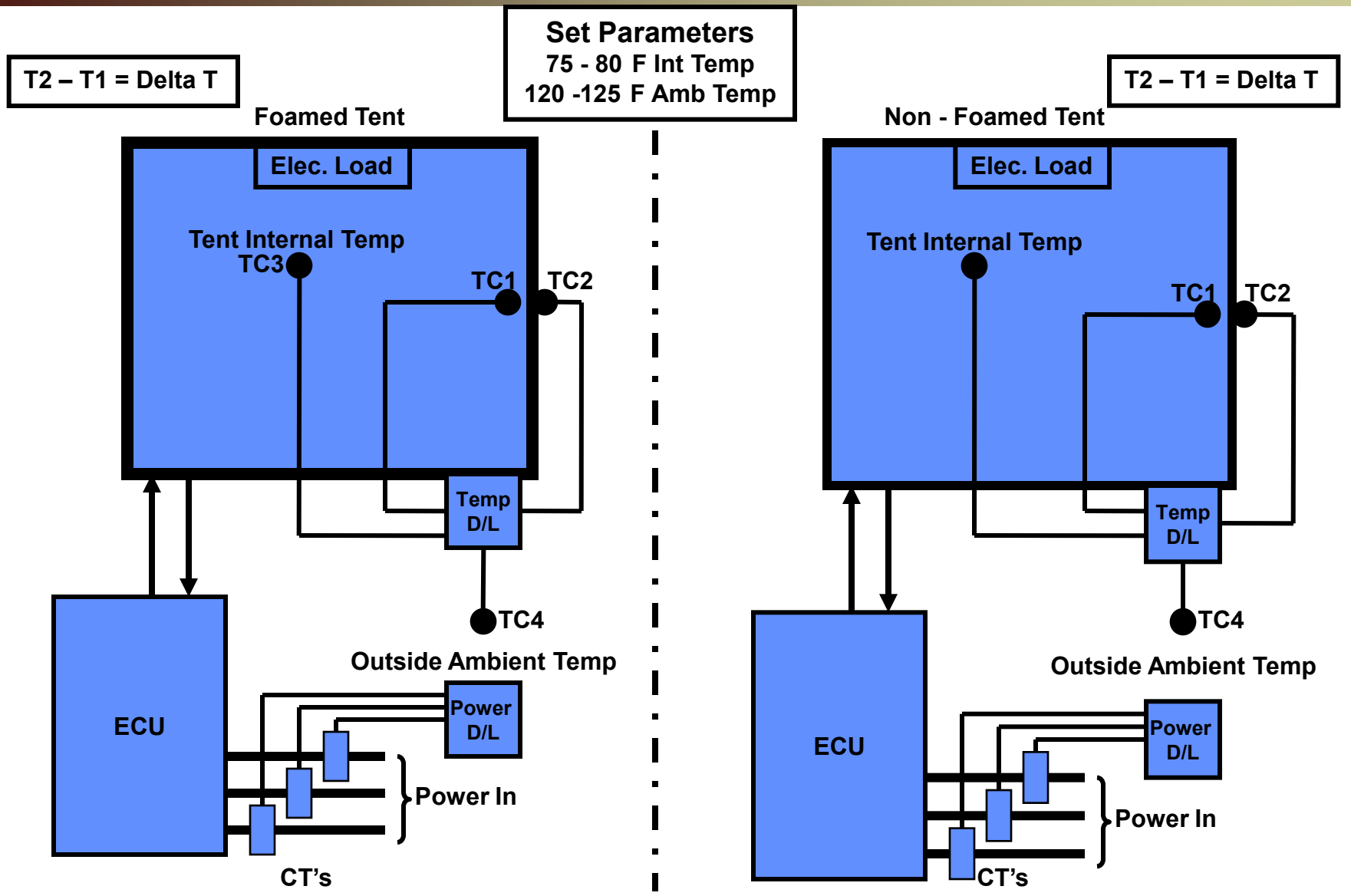
LSA WARRIOR – UNFOAMED TENT

Note: ECUs and CB BOXES are located on permanent concrete pads
Currently ECUs and PDS configuration are not defined



FOB KING/Miami – FOAMED TENT

Foamed and Non Foamed Tent Cooling load Comparison



Baseline Testing Equipment – ECU and Mission Loads

Data Logger

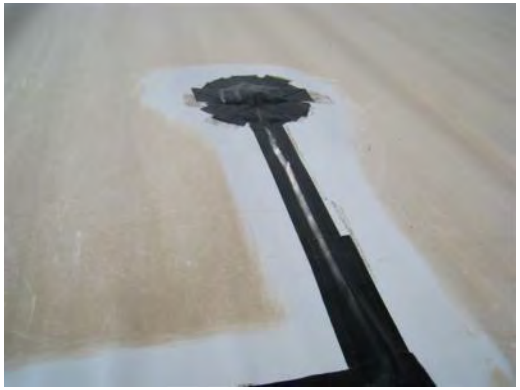
Data Logger location
Outside Tent

Ambient Temp Thermocouple

Outside

Inside

Tent Wall Thermocouples



Outside Wall

Inside Wall

Baseline Testing Equipment – ECU and Mission Loads

Power Adaptor Box to ECU (20T Unit)

Power Adaptor Box to HTR Pwr. Dist.

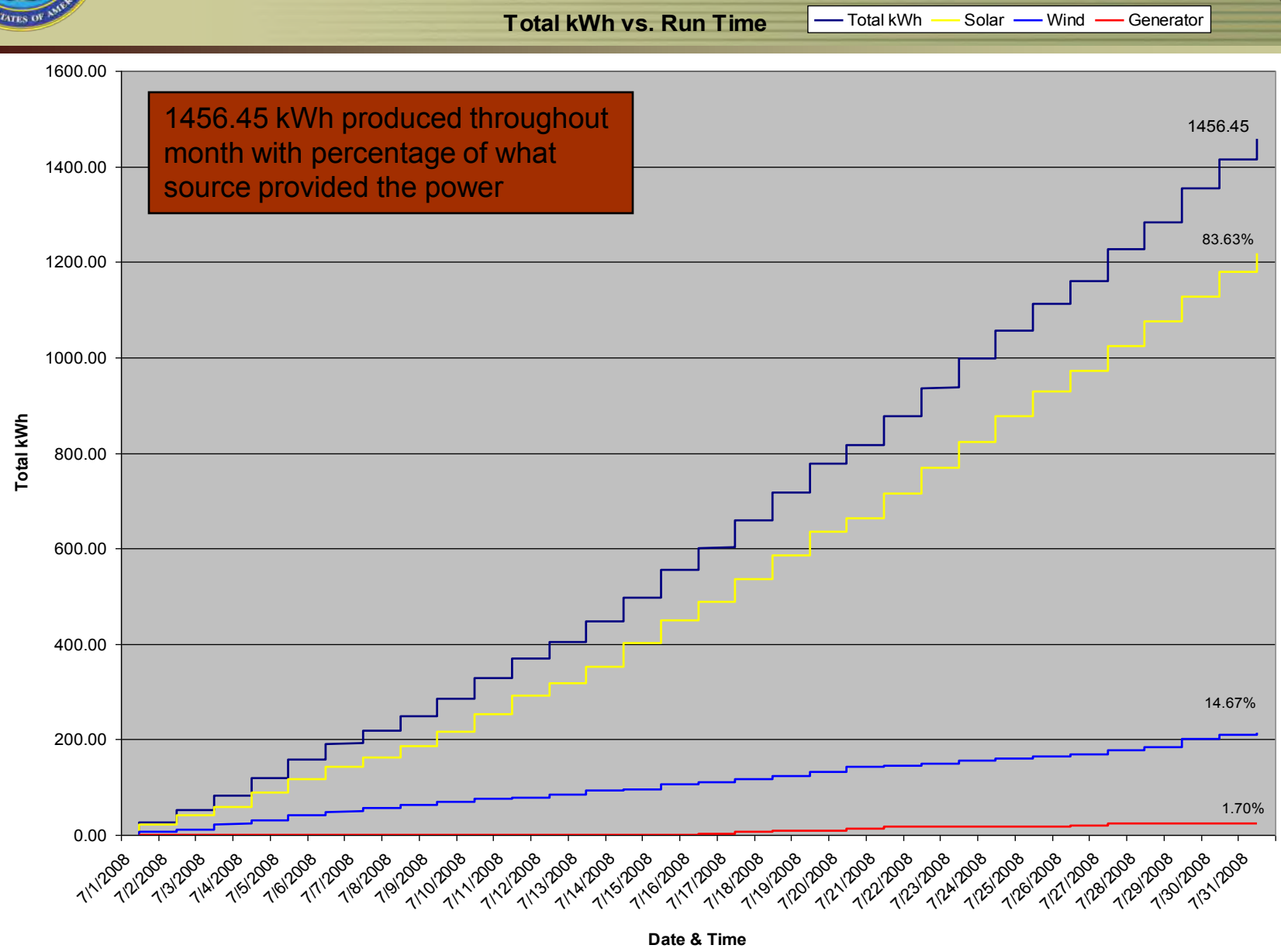
Tent Power Dist. Box

ECU Power Adaptor Box

Heater Power Dist. Box

Auxiliary Heater (2 per Tent)

Enduring Power Assessment - Dome Solar and Wind Data

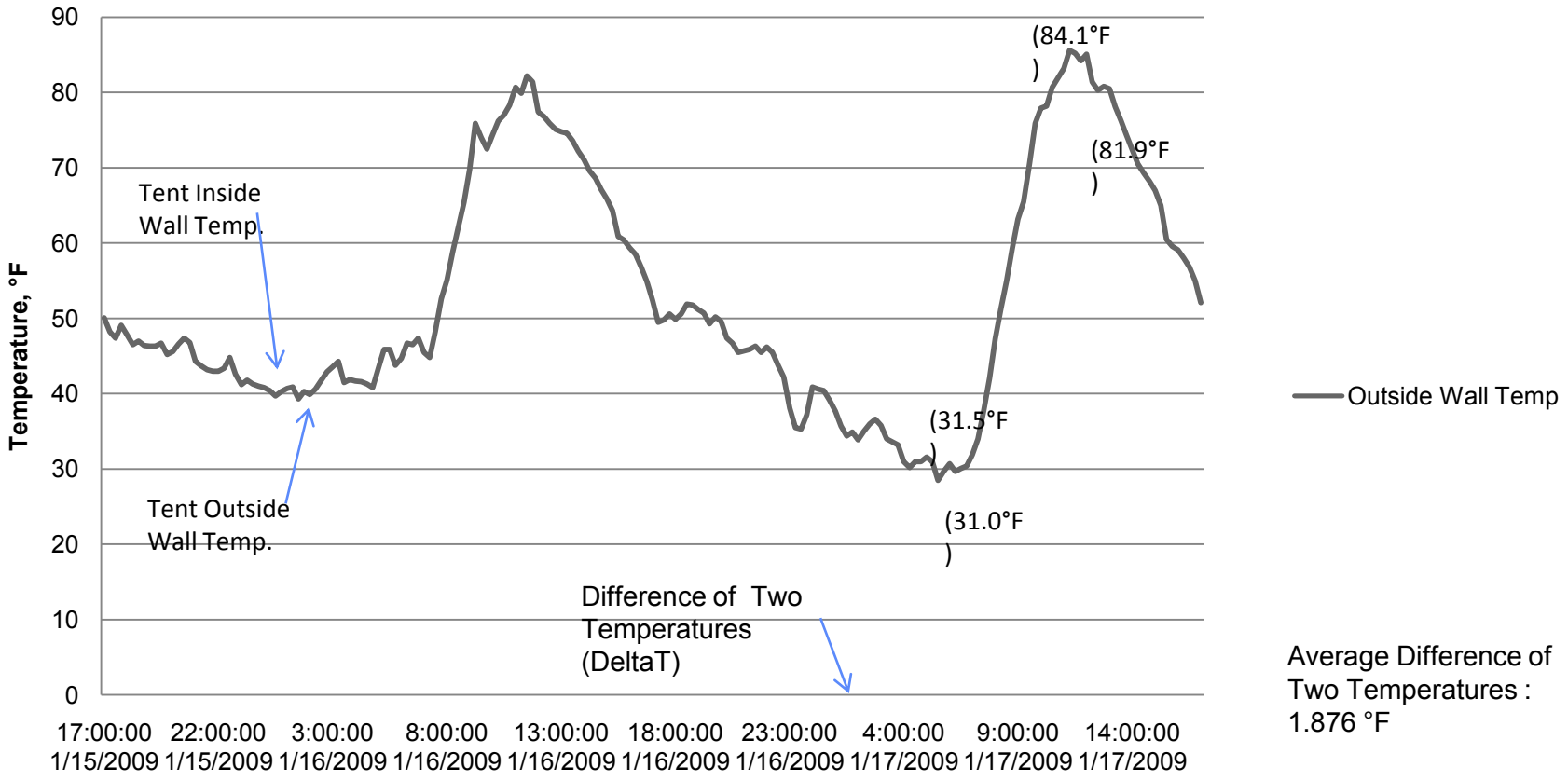


Energy Efficient Structures – Enduring Preliminary Analysis

- Raw data from July 1, 2008 through July 31, 2008
- Data in different supply sources including, wind, solar, and generator
- Characteristics of power available versus time of day
- Energy (kWh) produced from each source throughout the month
- Energy 'lost' by the system because the batteries are full and no demand for the power produced
- Battery voltage versus load & available power
- Load on the inverters versus the system response

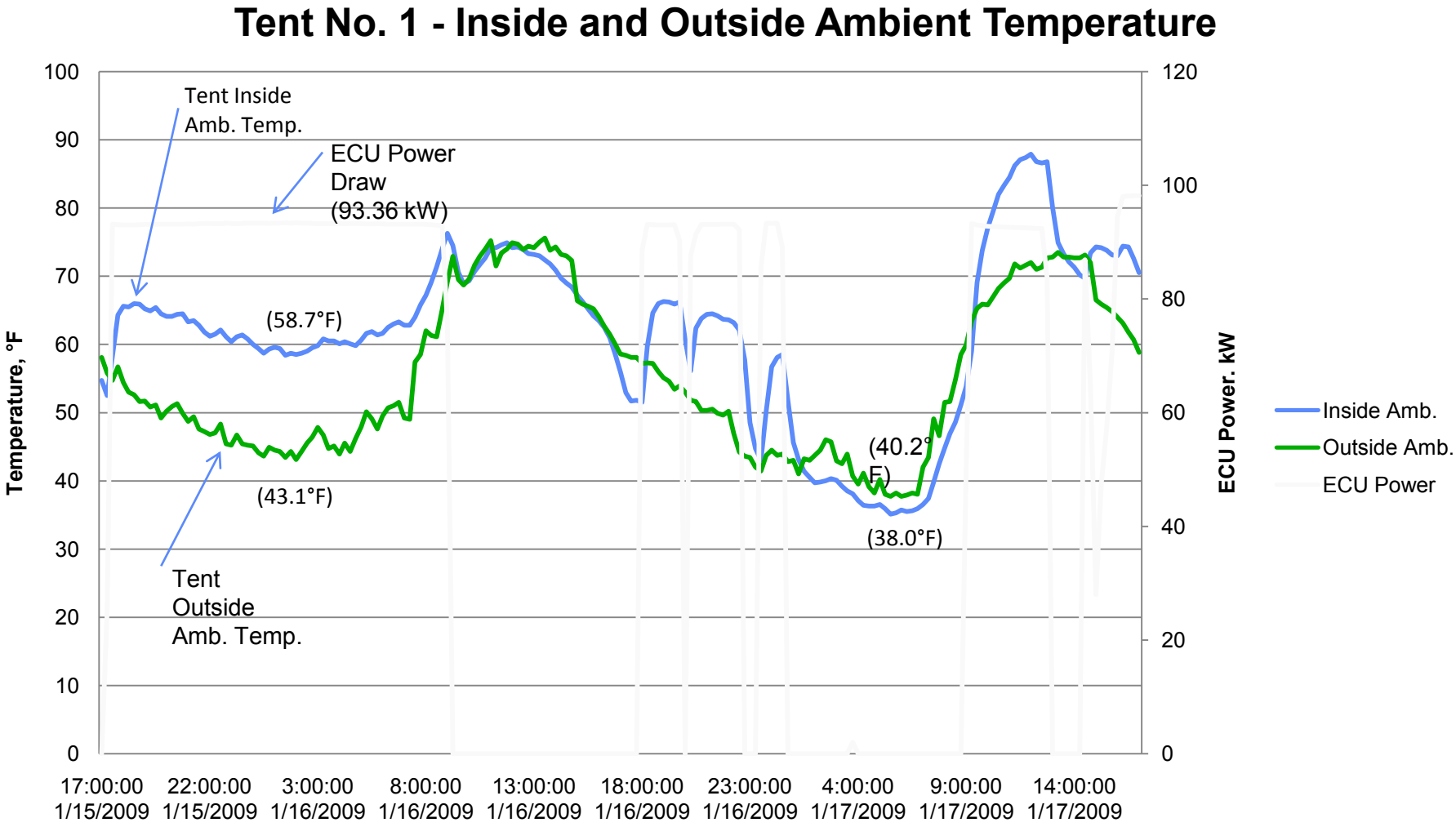
Energy Efficient Structures – Enduring Preliminary Analysis

Foamed Tent No. 1 - Inside and Outside Wall Temperature



Average Difference of Two Temperatures : 1.876 °F

Energy Efficient Structures – Enduring Preliminary Analysis



Points of Contact

- **Oversight Executive**
  - Gregory R. Reid, 703.601.2123, Greg.Reid@osd.mil
- **Technical Manager**
  - Ms. Barbara Brygider, 703.615.6774, bbrygider@comcast.net
- **Operational Manager:**
  - Mr. Thomas Smith, 813.827.3287, smithtr@centcom.mil
- **Transition Manager**
  - Mr. Chris Bolton, 703.704.1995, chris.bolton@us.army.mil
- **Data Acquisition/Analysis**
  - Mr. Noel Pleta, 703.704.2148, noel.pleta@us.army.mil